



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

SCIENCE

[Entered at the Post-Office of New York, N. Y., as Second-Class Matter.]

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

EIGHTH YEAR.
VOL. XVI. No. 388.

NEW YORK, JULY 11, 1890.

SINGLE COPIES, TEN CENTS.
\$3.50 PER YEAR, IN ADVANCE.

TORNADO LOSSES AND INSURANCE.

THE destruction of life and property by a tornado must ever be regarded as the most important fact from a practical standpoint, and in many respects this feature of the subject is involved in greater confusion and uncertainty than any other. As has already been said, such a violent storm ought to be exceedingly well defined, and the amount of loss determined within a small fraction. One reason for this uncertainty has been the lack of persons desirous of obtaining a complete list of property loss and damage by tornadoes. We have an excellent illustration of an opposite state of affairs in the estimates of loss of property by fire. Here there are hundreds interested in obtaining the exact loss; and it is believed that in this country the loss by fire, whether of insured or uninsured property, is known within four per cent of the actual loss. A most serious difficulty in making such estimates has arisen from a vague and indefinite idea of what a tornado is, and how it should be described. We are told, for example, "if we care for the name 'tornado' to define a distinct class of local storms, then the funnel-shaped cloud, as shown by a distinct rotary movement of the wind, or by peculiar destruction of property, should be made the condition of classification. Both for the purpose of study and practical results, this manner of distinguishing the tornado is desirable. It leaves no doubt as to where the line should be drawn, and recognizes a peculiar and important class of meteorological phenomena, independent of their effect upon life and property, which it is quite well known that they can destroy if given an opportunity." We must take most serious exception to these views. It is manifestly only by the effects displayed by these storms at the earth that we can classify or discuss them. The most violent commotions, the most surprising shapes and appearances of clouds meeting or rolling over each other, might have a passing interest, but surely they would be practically of no account if they did not reach the earth and there affect life and property.

Descriptions.

We have already seen that in the earlier history of these outbursts they became familiarly known by a definite name. For example: the New Brunswick (New Jersey), the New Haven (Connecticut), the Stow (Ohio), tornadoes are definite phenomena and extremely localized. In later times the most terrible tornado but one that has occurred in this country was that at Grinnell, Io. To call this the Poweshiek County tornado, and to say that it had a path 450 to 600 feet wide, takes from it almost entirely its definiteness and extreme destruction. In another instance a tornado is de-

scribed as causing a loss of \$4,000,000,—the greatest in this country, and, for that matter, in the world. This tornado is given a path 2,640 feet wide, and passing through Rock, Hennepin, Ramsay, and Washington Counties, Minn., and through St. Croix, Polk, Barron, Chippewa, and Price Counties, Wis. It is not intended, of course, to convey the idea that there was a clean sweep a half-mile wide through these nine counties; but, to one familiar with the more terrible storms, such a description would convey an idea of a most appalling disaster. A most careful study of this nine-counties tornado has revealed the most astounding result, that there were only two towns injured. The principal loss was at Clear Lake, Wis., \$139,100; and the other town was Marine, Minn., with a loss of about \$65,000. The total direct loss by this tornado in all the counties was not over \$250,000, or one-sixteenth the published loss. It should be insisted on, by all means, that every tornado should have a definite local application and a name. In some cases where the country is thinly populated, and houses are destroyed here and there through many townships, it will be necessary to group all such hamlets in the name of a county or of the principal town visited, but this should be rarely resorted to.

Indirect Loss.

Much confusion has arisen from grouping together losses by the tornado proper, and by floods and hail which accompanied it; also by considering losses to orchards, crops, fences, stock, etc., in connection with that to houses and buildings. Certainly, in calculating risks for tornado insurance, and in studying the definite losses, we should catalogue only the definite and direct loss to structures. It is not a little remarkable, that, while the descriptions of tornadoes have tended to vagueness and indefiniteness as to extent of path and destructiveness, no such difficulty has been encountered in photographing the effects of a tornado. The most completely destroyed houses and blocks, and scenes exhibiting the severest violence of the storm, have always attracted the photographer. This country has had over two thousand tornadoes since 1873, but we would be very much deceived if we thought that the scenes of desolation depicted in half a hundred photographs were experienced at more than two per cent of these. The worst of these photographs are taken from only two or three tornadoes.

Tornado Lists.

These are being published from time to time, and in the main are very untrustworthy, from a lack of care in collation, and a desire to exhibit some preconceived idea as regards the tornado. A careful sifting of the lists has shown that many of these tornadoes were of very slight account,

and many also were straight blows with little violence. Often a whirling cloud does not reach the earth, but it is called a tornado. In one list the Wallingford (Connecticut) tornado of Aug. 9, 1878, is put down as only a heavy thunder-storm, although it ranks among the severest of all, for there were thirty killed, fifty houses destroyed, and \$250,000 of damage done. There will be given later a list of forty-eight of the most severe tornadoes since 1873. No pains have been spared in making this list as complete as possible; and while in a few cases the loss may be slightly overestimated, yet in the main it is believed to be accurate.

Hinrichs's Views.

Mr. Hinrichs of Iowa has devoted many years to the study of tornadoes, and has given careful attention to the subject of a classification. A *résumé* of his views has been given in the *American Meteorological Journal* (vol. v. pp. 306, 341, and 385). He would make a careful distinction between a tornado and a squall, or *derecho*, as he would call it. The latter he describes as a straight-line heavy wind, usually advancing from the north-west for many miles across the State. While it is frequently destructive, yet it is of an entirely different type from the tornado. It is barely possible that there has been a slight confusion here, and that the apparent movement of the *derecho* from north-west to south-east is complicated by the occurrence of a series of tornadoes or destructive thunder-storms running in parallel lines from south-west to north-east. It hardly seems probable that we have to deal with a particular class of storm (*derecho*) in Iowa that is not found east of the Mississippi. What Mr. Hinrichs calls the "front" of the *derecho* may be either a thunder-storm or a tornado, and the universal law controlling these is a movement from south-west to north-east. We have already seen that these violent storms travel in parallel lines, beginning earlier in the afternoon at a point toward the north-west of a tornado region, and gradually working south-east. Each line occurs later and later, and it is also a fact that frequently the later storms have the longer paths. These appearances might also occur in a *derecho*.

Hinrichs's Classification.

The following shows the classification of tornadoes according to Hinrichs's method:—

A. Notable Tornadoes.

Class I. Multiple.

(a) Large.

(b) Small.

Class II. Single.

(a) Large.

(b) Small.

B. Minor and Doubtful Tornadoes.

Finley's Classification.

Lieut. Finley would make no effort at a definite classification according to violence or extent, but would take every funnel-shaped cloud, whether it reaches the earth or is seen in the clouds, and give it a county, date, time of occurrence, direction of motion, shape of cloud, and width of path.

Objections.

Neither of these methods seems satisfactory for our purpose. The first is quite involved, and, moreover, unites two

tornadoes under the same head, though they may be twenty miles apart, provided they occurred on the same date. The motion of a tornado is complex: it oftentimes lifts, and passes a dozen miles before again striking the earth. Again, we have several occurring in parallel paths on the same date. To unite these together under the head of a "multiple tornado" seems very injudicious. It will serve to great definiteness if we consider each descent of a tornado-cloud, and each occurrence of destruction in parallel bands, as a separate tornado. My meaning should be distinctly understood. I would call the tornado of St. Cloud and Sauk Rapids, Minn., a single occurrence, because the cloud did not lift between these two; also the Louisville and Jeffersonville tornado was a single occurrence, for the same reason. I would call the Fayetteville (Arkansas) and Marshfield (Missouri) tornadoes separate occurrences, though having the same date, April 18, 1880. They were a great many miles apart, and, while undoubtedly in the same tornado region, yet they should be kept distinct.

Scale of Violence.

The establishment of a scale of violence is one of the most important steps to be taken at this stage of our studies and information. The question arises at once as to whether this scale should be according to the violence displayed in twisting trees and destroying houses, or according to the property loss. The former would be a very difficult matter to determine, but should certainly be coupled with the extent of region over which the manifestation occurred. It is also true that we should have with every tornado and destructive storm a definite estimate made, as impartially as possible, of the property loss. We may hope ere long that a beginning of interest will occur and develop in this direction, as has already appeared in the study of fire losses. By what precedes, it is plain that our ultimate arrangement of tornadoes according to a scale would place the more violent in a slightly different position from the more destructive; but this difference is exceedingly slight, and, until we make finer distinctions than are possible now, we can easily place the most violent and destructive in a class by themselves, or on a scale of 3 in class (3). Going to the other end of the scale, we will put the least violent at (1), and (2) will comprise all between these two. Of course, no hard and fast line can be drawn between these different grades, and some would put a few on the border of (2), in (3), and *vice versa*, but this is a very small matter. It is very important that in our lists the dates be arranged chronologically; but, if we wish to make a distinction between tornadoes at the border-lines, we may do so by using the plus and minus signs: for example, (3—) would be near to (2+), and (3+) would be the highest in the scale. This would be a step toward dividing into nine classes instead of three. Another method of classification would be to determine the number of houses destroyed in each tornado, and then arrange the list on this basis. Such a list would not differ materially from the former. The only difficulty would be in assigning the proper number of houses under each scale. For purposes of comparison and in computing risks, we might also arrange a list of towns destroyed, or partly destroyed, according to an arbitrary scale. It matters little what method we adopt, for it is probable that any scheme

would give practically the same final comparison, but it is absolutely essential that we adopt some scale.

Authorities.

The most complete general description of tornadoes is to be found in the *Monthly Weather Review*, published by the Signal Service. In addition, we have descriptions of violent storms in our newspapers, and publications by Lieut. Finley. The most complete list of tornadoes has just been finished by Lieut. Finley in the *American Meteorological Journal*. This contains only the date, time of day, width and direction of path, and gives us no idea whatever of the destruction, which is by far the most important characteristic, and the only one that concerns us here. It has been found impossible to use this list, and the original authorities have been studied in making out a final description of tornadoes for this discussion. The method adopted for this list was to form as clear an idea as possible of the amount of violence and loss that should be given to each division of the scale, and then to put each tornado and violent storm rigidly in its proper place. If any doubt occurred as to whether the storm came, for example, in (3) or (2), it was indicated by a minus or plus sign, as just described. It was found necessary to begin the list with 1873, and it ends with 1888. The total number of tornadoes during these sixteen years was 2,221; or, by scale, 48 (3), 988 (2), and 1,185 (1). In the

Résumé of Tornadoes, 1873-88.

	NUMBER.					Loss.			
	(3)	(2)	(1)	Total.	Total by Weight	(3)	(2)	(1)	Total.
Alabama.....	3	55	20	78	139	\$380,000	\$1,100,000	\$60,000	\$1,540,000
Arkansas.....	4	35	24	63	106	430,000	700,000	72,000	1,202,000
Georgia.....		77	53	130	207		1,540,000	159,000	1,699,000
Illinois.....	6	102	129	237	351	1,250,000	2,040,000	387,000	3,677,000
Indiana.....	2	56	58	116	176	275,000	1,120,000	174,000	1,569,000
Iowa.....	3	61	75	139	206	740,000	1,220,000	225,000	2,185,000
Kansas.....	3	103	109	215	324	350,000	2,060,000	327,000	2,737,000
Michigan.....		31	48	79	110		620,000	144,300	764,000
Minnesota.....	3	29	45	77	112	1,000,000	580,000	135,000	1,715,000
Mississippi...	4	25	18	47	80	620,000	500,000	54,000	1,174,000
Missouri.....	7	76	60	143	233	1,185,000	1,520,000	180,000	2,885,000
New York..	1	49	70	120	171	80,000	930,000	210,000	1,270,000
North Carolina		32	30	62	94		640,000	90,000	730,000
Ohio.....	4	84	87	175	267	1,030,000	1,680,000	261,000	2,971,000
Pennsylvania..		45	66	111	156		900,000	198,000	1,098,000
South Carolina	1	29	20	50	81	200,000	580,000	60,000	840,000
Wisconsin.....	3	53	48	104	163	650,000	1,060,000	144,000	1,854,000
Total.....	44	942	960	1,946	2,976	8,190,000	18,840,000	2,880,000	29,910,000
All States...	48	988	1,185	2,221	3,305	9,650,000	19,760,000	3,555,000	32,965,000

accompanying table are grouped these tornadoes in the seventeen States in which they are the most frequent. A careful study of this table will reveal most interesting and unexpected results. That Ohio, New York, and Pennsylvania

should stand so high in this list is largely due to the fact that tornadoes have been so thoroughly reported in those States. A severe storm in any one of these States is noticed far more than in States where local storms are more abundant. An attempt has been made to determine the total tornado loss in these States. Outside of the forty-eight most destructive, scale (3), it is impossible to get an accurate estimate of the average loss. In two instances where the newspapers had reported great loss by a funnel-cloud, a careful examination revealed the fact that such a funnel-cloud had reached the earth; but the total damage in one case was \$200, and in the other \$75. Whatever may be the estimated loss, we have here the figures giving the number of tornadoes, and we can easily determine the true loss if at any time we find the average loss. After a careful study of the reports, it has been decided to place the average loss by tornadoes, scale (2), as \$20,000 each, and by (1) as \$3,000 each. There is no doubt at all that this estimate is at least ten per cent too great. The figures in the last column of this table give the total loss in each State. Taking the total number of tornadoes from 1873 to 1888, or 2,221, and dividing the total loss, \$32,965,000, by it, we obtain \$14,842 as the average loss by each tornado.

These figures are very significant, and will bear the closest scrutiny. We may make an interesting comparison with the only other list that is at all complete. This contains 2,435 tornadoes as having occurred in this country, with a total loss of \$941,282,500, or a loss by each tornado of \$386,564. Taking the forty-eight tornadoes in the above list, scale (3), we find the total loss, as carefully determined, \$9,650,000, or a loss of \$201,042 for each; that is to say, if the former estimate has any value at all, this country has been visited by 2,435 tornadoes, each of which was nearly twice as destructive as each one of the forty-eight tornadoes known to be most destructive. It is safe to say, that, were our Western States subject to such appalling disaster as this, they would have been depopulated long ago. We have just seen that from 1873 to 1888 the average loss by the 2,221 tornadoes was \$14,842, with a margin of at least ten per cent too great an estimate; or, in other words, the actual loss from tornadoes in this country is one twenty-sixth, or only four per cent, of that estimated in the list above.

It will be distinctly understood that there is no desire in all this to make out that there is no danger from tornadoes, or to minimize their effects. It is of the utmost importance that the true facts be established; that the people understand that entirely unnecessary fears have been aroused; and that the extremest exaggeration has occurred from, it is to be feared, an unfortunate desire to influence their actions in regard to tornadoes. The worst is bad enough without exaggeration. Fears have also been engendered from an extreme agitation of this subject in the line of protecting lives from these outbursts. The protection of life is the most important of all, but there is no necessity of going to the expense of having a so-called tornado-cave constructed, and, above all, of spending hours in such a cave, as we have frequent reports of persons doing because of terror inspired by improper reports. It is probable that no tornado ever visited a place without giving ample warning by the great roar (in some cases reported as thirty minutes, and even more, before the outburst) or by the unmistakable funnel-cloud. A cellar under the

house is an ample protection, and none other is really needed. Above all, the people of the West should allay their fears at the appearance of every threatening or lurid cloud in the south-west horizon.

Warnings.

As the Western States become more thickly populated, it is probable that some means will be resorted to, to warn the villages of the approach of a veritable tornado. Outposts placed at a mile or two to the south-west or west would have an excellent opportunity to watch for such outbursts, and give the signal for the inhabitants to watch for the cloud. It would be a great advantage to all concerned if people could realize that the tornado proper is an exceedingly definite and unmistakable phenomenon; that it does not come upon a house like a stroke of lightning, unseen and unheralded. Instances are by no means rare where the funnel has been seen advancing directly over a person, and has been easily avoided by running to the north or north-west. On the south side of the path there are indraughts extending to quite a distance; so that it is generally safer, unless the track of the tornado is seen to be quite to the north of the observer, for one to run to the north-west, but never to the north-east or east, as that is in the line of the tornado. Persons have stood within one hundred and fifty feet of the tornado on the north side, and have felt no unusual disturbance. It is admitted, however, that this requires no unusual courage. Let the people of the West look upon this phenomenon more in the light of its great peculiarity and wonderful nature,—a nature which has absolutely no parallel, and one the study of which must be for years to come of the highest importance. The wisest philosopher has hardly begun to get an inkling of its formation; and those who are so minded can, by a careful observation and record, help in obtaining and formulating the facts regarding this extraordinary appearance.

Can the Tornado Energy be Dissipated?

The time is coming when this question will become exceedingly important. It is very unsafe to theorize without some facts to start from. It is probable that often serious damage will be warded off from a town which has an extensive forest to the south-west and west. If the energy of a tornado is in an electrical action, as it most undoubtedly is, there is no reason why this may not be diminished by a properly arranged network of wires and poles to the south-west. A tornado is exactly the same as a water-spout at sea; and, if ships have broken up such a spout from the concussion produced by the firing of a cannon, there seems no reason why the energy of a tornado may not be largely diminished by the explosion of gunpowder or dynamite. Of course, the great difficulty would be to make the explosion anywhere near the tornado. Further than this, we cannot go without experiments, and, above all, without a better knowledge of the force producing the energy manifested.

Insurance.

Next to the loss of life and destruction of property by a tornado comes the practical question, "Can I and shall I insure my property against this loss?" Undoubtedly both the public and insurance companies have been misled on this subject, and yet it will be distinctly understood that in

whatever is written here there is no censure implied. I have been in correspondence with these companies, and find that they have been groping in the dark; but they are watching tornado risks very carefully, and are prepared to make a change when such is deemed advisable. It is a remarkable fact, that, out of the thousands who have insured their property against tornadoes during the past six years, only two, so far as published, have received any return, and these for \$2,000 each. If we should examine the returns for fire insurance, no such state of affairs as this would be found, and the reason for it is not far to seek. Usually tornado insurance is placed in the towns where a tornado has just occurred, and, like lightning, the path of a tornado never runs twice in the same line. When we consider the extremely narrow path of a tornado, this is not to be wondered at. After the recent tornado in Louisville, Ky., we are told that tornado insurance had a most extraordinary boom, and it was being placed at a rate even greater than that for fire insurance in some cases. This is most extraordinary, and can only be explained on the supposition that all classes had had their attention called to incorrect views, and were not cognizant of, or had not studied, the true relations of the subject. We have already seen that in the nine-counties tornado the actual losses of \$250,000 were exaggerated to \$4,000,000; but what shall be said when we learn that after the returns from all tornadoes were in, and we must consider that these returns represented far more than the actual loss, it was decided to multiply them by 25, that is, increase the losses by 2,500 per cent, on the plea that all the losses were not reported. It is not to be wondered at that under such manipulations every one has been very much mystified. As to the Louisville tornado, we shall find that Kentucky is not classed as a tornado State even. It is doubtful if another such tornado ever strikes Kentucky, certainly not in a hundred years.

Risk.

This whole matter of insurance depends on the risk. If a company should be organized to insure a house against being knocked down by a meteor, no one would dream of such a thing as noticing it, except in pity. No company was ever organized to place insurance against lightning distinctively; but the risk is so slight, that all or nearly all companies simply add that risk to the regular fire risk. I think it can be shown that the tornado risk is not so vastly different from that of lightning. Suppose a man's life is insured, and he wants to go into a tornado region: not one word is said by the company. But suppose the man goes South during the summer season: he must take his own risk, for the company will not take it. The difference in these cases is very plain: the chance of death in the first instance is perhaps one in a million or less, while in the second it may be one in a thousand or more. These illustrations will suffice to make this subject clear to those who have given no thought to it. If we can find the relative risk between lightning and tornadoes or between fire and the same, or if we can find the chance that any given house will be struck, we shall have a basis upon which to reckon the importance of this insurance. It is an eminently practical question to be solved by the law of chances, and not an undetermined factor, or a subject to be accounted for on the plea that it is the

working of an inscrutable providence; and we must be resigned to our fate if we do not insure against it. The fire hazard has been very accurately computed, and it is known approximately just how many persons will insure their property, and how high it is necessary to put the premium in order to pay the losses and expenses. Whenever a tremendous conflagration like that of Chicago or Boston breaks forth, these estimates are entirely wrong, and many companies are forced to the wall. It is impossible, however, to allow for such calamities; and it is probable, that, excepting some minor changes, no radical change in fire insurance has occurred on account of those fires.

Tornado Risk.

If we knew, approximately even, just the loss from tornadoes, and could place the insurance where the loss of houses blown down and the expense of insurance would not be greater than the gain in premiums, we would have an ideal state of insurance, and we could tell just the amount each householder should pay. Or if we knew just the average loss per year in the tornado States, and could persuade enough people to take up this kind of insurance, it is plain the business could be carried on profitably. One difficulty now encountered is, that people do not ordinarily see that the risk is any thing like that represented (which is true), and consequently only a small fraction of this kind of insurance is taken as compared with fire insurance. It would take a great many years to determine tornado risks with sufficient accuracy to estimate the amount of premium needed; but we can make a comparison with the risks and losses by fire, and thus arrive at an approximate solution of the question. It should be noted, however, that these risks are of very different characters. The fire risk is ever present and a perpetual menace. Moreover, it is one which is in great danger of propagating itself, or becoming enormously great by communication from house to house. A tornado is more like an accident: it happens at the rarest intervals, and there is no spreading. We might compare these risks as those coming to a man's life in going to a fever district and in going to a tornado district respectively, as was done above. It may be objected that we cannot compare fire insurance with that for tornadoes, in that fire losses are much greater in large cities, where the population is denser than in the country. The objection is not a serious one, for the reason that the greatest destruction from tornadoes has been in our large cities; and, again, the protection against fire is much more perfect in the city than in the country; in fact, insurance premiums are less in the city than in the country on a great many kinds of property.

[Continued on p. 22.]

NOTES AND NEWS.

THE *Open Court* of Chicago has republished in a volume entitled "Wheelbarrow" a series of articles and discussions on the labor question that have been appearing in its columns for some time past. The anonymous author of the work tells us in his introductory chapter that he was for a considerable part of his life a manual laborer, though he has since risen to higher positions. Hence he speaks of the workingman's life from actual experience, and so far is qualified for the work he has here undertaken. But unfortunately he has not taken the trouble to study the scientific aspect of the subjects he deals with, and even confesses his mental

incapacity to do so. He has, however, many sound and sensible ideas, though none of them are new. He is opposed to all forms of communism and anarchism, and equally so to Henry Georgeism, and animadverts severely on the monopolistic spirit of the trades unions. But he writes in a coarse style, and often in a tone of arrogance and of bitterness towards capitalists that repels the reader. On the whole, we cannot see that he has contributed any thing to the solution of the labor problem.

—It is a well-known fact in biology that bacteria and bacilli absorb aniline and are killed by it. Two German observers—Stilling and Wortmann—have recently considered the possibility of utilizing this property in medical treatment (Humboldt). The diffusibility and harmlessness of violet aniline dyes (called, for brevity, "methyl-violet") without arsenic, in small doses, were first demonstrated on rabbits and guinea-pigs, as we learn from *Nature* of June 26. Then certain eye-disorders were produced in those animals, and treated with aniline solution, the results being excellent. The authors proceeded to operate on the human subject. A skin ulcer on a scrofulous child, which had been treated for a month with the ordinary antiseptic agents without success, was gradually healed by daily dropping a little aniline solution on the sore, and similar good results were had with bad cases of eye-disease. It soon appeared that many surgical cases were open to successful treatment in this way, and that, in general, wounds and sores developing suppuration could be sterilized with aniline. It is also thought that cases of internal inflammation, as in pleuritis and peritonitis, may prove to be not beyond the reach of this order of treatment.

—The commission appointed to consider the question of coal-waste in the State of Pennsylvania,—J. A. Price, E. B. Coxe, and P. W. Sheaffer,—who may be addressed at Scranton, Penn., are desirous of making the investigation as comprehensive and as exhaustive as possible. It is of course absolutely necessary to obtain the results of all the best practical experience upon the subject, so as to, as far as possible, diminish in the future the waste, and to encourage the utilization of what are now waste products. This commission would be very glad to have a full expression of views upon any of the following divisions of the subject which they have adopted for the study of this most important problem. The divisions are as follows: geological and statistical waste, including estimate of the original geological coal-field and waste of erosion, estimate of existing coal-field before coal-mining began, estimate of amount worked to the present year, and estimate of the total amount that it is possible to take from the earth by any known system of mining (giving the amount that must be left in the ground in shape of pillars, etc., or what may be regarded as permanent structural waste); waste of producing and marketing, including investigation of the underground waste of mining, investigation of the waste of preparation (including all processes in which the commercial size has been continually reduced, the amount of culm in sight at place of preparation, and the annual product of culm), and investigation of the marketing of the pea, buckwheat, bird's-eye or rice, and dust, and the uses to which the several sizes or conditions are put; utilization of coal-waste, including examination of the whole briquette system, duly recorded tests under responsible supervision, patent office records, specimen forms, and chemical analyses, accumulation of the record of all the practical mechanical appliances by which the waste is utilized without mechanical preparation (such as devices of furnaces, grates, blowers, etc.), investigation of the use of waste after mechanical preparation for combustion (as in pulverized conditions, etc.), and examination of the gasifying processes into water-gas and producer-gas, also in the destruction of garbage or cremating work, also in agricultural experimentation.

—According to a newspaper bulletin just issued by Dr. C. M. Weed, entomologist of the Ohio Experiment Station, the maple bark-louse has become destructively numerous over a large portion of Ohio, and is creating much alarm by its presence. It is especially at work upon the shade-trees of cities and villages, and unless checked there is every indication that the trees will be seriously injured. The insect has been reported as very abundant

SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

47 LAFAYETTE-PLACE, NEW YORK.

SUBSCRIPTIONS.—United States and Canada..... \$3.50 a year.

Great Britain and Europe..... 4.50 a year.

Communications will be welcomed from any quarter. Abstracts of scientific papers are solicited, and twenty copies of the issue containing such will be mailed the author on request in advance. Rejected manuscripts will be returned to the authors only when the requisite amount of postage accompanies the manuscript. Whatever is intended for insertion must be authenticated by the name and address of the writer; not necessarily for publication, but as a guaranty of good faith. We do not hold ourselves responsible for any view or opinions expressed in the communications of our correspondents.

Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

VOL. XVI. NEW YORK, JULY 11, 1890. No. 388.

CONTENTS:

TORNADO LOSSES AND INSURANCE	BOOK-REVIEWS.	
H. A. Hazen 15	Advanced Physiography.....	25
	Graphical Statics.....	25
NOTES AND NEWS..... 19	Cycling Art, Energy and Locomotion.....	25
M. PASTEUR AND HYDROPHOBIA	Steam.....	26
Thomas M. Dolan 23	AMONG THE PUBLISHERS.....	26

TORNADO LOSSES AND INSURANCE.

[Continued from p. 19.]

Constancy of Tornadoes.

It is an exceedingly important question to determine, if possible, whether tornadoes are on the increase, or whether we may reason from their occurrence in the past as to their probable action in the future. The tendency is to take serious alarm when a tornado has happened near a community, and to conclude at once that the risk has suddenly become very much greater than before, and is likely to continue. We may cite as an instance the alarm in a good many minds after the occurrence of the recent Louisville tornado. Notwithstanding the fact that this was the first serious tornado in Kentucky, and that in all probability another such would never occur there, certainly not in Louisville, yet many seem to have thought that a change had come in the climate, and we were now to have more of these outbursts. A careful study has shown that such fears are groundless, and that our climate is practically constant. We may strike an average of tornadoes in the past, and reason that there will be no more than that average in the future. In fact, if we include 1883 and 1884 in our average, we know that it will be too great, for a very large number

of tornadoes occurred in those years. It is to be noted that the reports of tornadoes must necessarily increase as houses increase in the tornado States, but this will be balanced by the fact that fire losses will also increase. It is perfectly safe for us to compare fire and tornado losses, and to determine approximately what the comparative premium should be.

The accompanying table shows for the years 1876-84, in the seventeen tornado States, the total loss by tornadoes of scale (3), (2), (1); the loss by fire during the same years; and the relative loss by the two.

Tornado and Fire Losses in Seventeen States, 1876-84.

	NUMBER.			LOSS.		
	(3)	(2)	(1)	Tornado.	Fire.	Tornado Fire.
Alabama.....	1	30	8	\$704,000	\$6,169,000	1-9
Arkansas.....	3	21	18	754,000	6,419,000	1-9
Georgia.....		54	32	1,176,000	14,083,000	1-12
Illinois.....	4	77	87	2,601,000	38,060,000	1-15
Indiana.....	1	42	30	1,005,000	22,981,000	1-23
Iowa.....	3	42	50	1,730,000	14,821,000	1-9
Kansas.....	2	77	68	1,944,000	6,108,000	1-3
Michigan.....		24	18	534,000	30,583,000	1-57
Minnesota.....	2	20	23	1,069,000	18,752,000	1-18
Mississippi.....	4	21	15	1,085,000	5,479,000	1-5
Missouri.....	7	61	45	3,250,000	27,129,000	1-12
New York.....	1	34	33	859,000	124,767,000	1-145
North Carolina.....		18	11	393,000	6,486,000	1-17
Ohio.....	2	42	35	1,225,000	41,496,000	1-34
Pennsylvania.....		22	22	506,000	69,869,000	1-138
South Carolina.....	1	24	12	716,000	7,747,000	1-11
Wisconsin.....	3	39	33	1,529,000	21,375,000	1-14
Total.....	34	648	540	20,080,000	462,324,000	1-23
Total, omitting Pennsylvania & New York	33	592	485	18,715,000	267,688,000	1-14

The tornado loss in this table has been rigidly computed from the actual estimated loss for scale (3), and allowing \$20,000 each for (2), and \$3,000 each for (1). There is no doubt that this loss is more than ten per cent too great. It should also be remembered that during the two years 1883 and 1884 there were as many tornadoes as in the remaining seven, and in the sixteen years thus far studied this is very nearly the relation. There are several most astonishing facts brought out in this table, and such as are very difficult to understand. Perhaps the most surprising result is that in Kansas the tornado loss is one-third of that by fire. I have gone over the data, and can find no flaw. All the tornado reports from the different States were treated exactly alike, and the result for any one State may be compared directly with that for any other. In Nebraska, a neighboring State, the tornado loss is insignificant, not more than one-twentieth of that by fire; and in Missouri it is one-twelfth of the fire loss. Of course, where no estimate of the loss is given, as is the case in more than half the occurrences, the position in the scale is dependent on the reported violence of the tornado. I am inclined to think that Kansas has had

its severe storms multiplied by reporters to too great an extent. It seems necessary to give these figures exactly as they came out; and I shall be very much gratified if the citizens or professional men of any State, feeling that their State has not been given a fair show, should make for themselves a careful canvass of the State for tornado losses. I shall be pleased to send to any such State a list of the dates of all the tornadoes reported from that State, for the authorities or those interested to verify the losses sustained. I have attempted, by correspondence and in other ways, to get more complete returns, but there seems to be great apathy on this question. Possibly many have been very much discouraged at the palpable exaggerations that have been published. It seems to me that this matter is of the greatest importance, and now is the time to establish an accurate estimate of tornado losses which will be of permanent value for comparison with future years. Certainly more harm will come from vague reports of doubtful tornadoes and exaggerated statements of losses than can ever come from an exact knowledge of the truth. There is no doubt that there is a tornado evil. Let us learn its exact proportions, and then people will know just what to prepare for.

I do not think that in this table the States of New York and Pennsylvania can be regarded as full-fledged tornado States. Moreover, the comparative loss between fire and tornadoes is not the same as in the other States, owing to the relatively greater loss by fire in the cities in these two States. I have therefore taken out these two States in the final summing-up of the table. Kansas has been left in, however. We find that in the fifteen remaining States the relative loss was one-fourteenth; that is to say, the loss by tornadoes is seven per cent of that by fire. I think we may safely say that any fire insurance company would be entirely secure if they increased their premium by eight per cent or ten per cent, and assured the householder against loss from tornadoes as well as fire, provided such insurance could be placed through all the fifteen States, and for a term of four or five years. As will be shown later, there seems to be good evidence for believing that once in eleven years the risk from tornadoes is somewhat increased for two or three years. When we see that insurance companies, computing from imperfect tornado losses multiplied by 25, have charged the same for both fire and tornado insurance, it is not to be wondered at that so few have taken the latter. Every one has the evidence of his senses that tornado losses in his community in fifteen to twenty years, excepting a few of the more disastrous tornadoes, have not equalled the average fire loss in a single year. It is said that such matters generally adjust themselves through a competition and rivalry between different companies, but it is very unfortunate for a few who have to suffer while this adjustment is taking place. Will it not be far more satisfactory to insured and insurers if this subject be thoroughly ventilated, and a good idea of the comparative risk between fire and tornadoes be arrived at? It should not be forgotten that it is only by uniform action and support of both fire and tornado insurance by the people in the fifteen States, that any thing like an average result can be obtained; or, at least, this must be the case in any one State, for there are a few lines of action in the State which seem to be more favorable for the development of tornadoes than the whole area of the State. H. A. HAZEN.

M. PASTEUR AND HYDROPHOBIA.¹

IT is now five years since M. Pasteur introduced to the medical world his alleged cure for hydrophobia. If his much-vaunted discovery possesses all the merits which have been claimed for it, he has earned a fair title to the gratitude of mankind. If, on the other hand, it can be shown that all his theories depend for their acceptance upon a number of very serious fallacies, and that his alleged cures are no cures at all, inasmuch as in those cases the disease never existed, and yet further, that in many cases his treatment has actually induced hydrophobia where it was previously non-existent, M. Pasteur's claim to be regarded, on account of this treatment, as a benefactor of his race, must fall to the ground.

It is now thirteen years since I first wrote a series of articles for the *Medical Press and Circular* on this subject, and they were subsequently published in book form under the title "Rabies and Hydrophobia." On that occasion I pointed out a very serious fallacy underlying many cases of alleged cure of this disease,—the fallacy of regarding persons bitten by healthy dogs as in danger of hydrophobia. At that time I investigated carefully a number of cases of alleged cures by a clergyman residing near Burnley, who had a great reputation in Lancashire for the cure of hydrophobia. The result of my inquiry showed that the Rev. Dr. Verity, the clergyman in question, had had a large number (two thousand) of dog-bitten patients. A few of them had died from hydrophobia after his treatment; but the majority escaped, the reason being that they had been bitten by non-rabid dogs, or had been bitten through clothing, etc. I inquired into numerous other alleged cases of cure of hydrophobia, but always with the same result; and I was thus led to formulate this proposition,—“that if any one obtained a reputation for the prevention of hydrophobia, and if all the dog-bitten sought or took this remedy, the result would be statistically favorable.”

When M. Pasteur startled the world by his first statistics, I was disposed to believe that in the hands of a man of such great scientific fame a cure had been found. I could not, however, avoid noticing the same fallacy running through his statistics which characterized the returns made by the Rev. Dr. Verity. The dog-bitten were certainly rushing to M. Pasteur; but the results were robbed of much of their marvellous character if it could be shown, that, owing to panic and fashion, great numbers bitten by non-rabid dogs were seeking protection.

This objection was supported by another, very powerful consideration. I found, on carefully comparing the statistics given by M. Pasteur with those of the years which preceded the introduction of his system, that the supposed rabid dog-bitten in France had increased in extraordinary proportions: while, at the same time, the average mortality from rabies in France had shown but little fluctuation.

The arguments I have already given are such as will appeal at once to the lay mind. There are, however, certain scientific objections which are still more cogent. The action of the supposed prophylactic, when examined, resolved itself into pure empiricism. A number of injections of rabbits' spinal cords, that had been dried from fourteen to five days, were used, and the old *post hoc* argument was employed: because the children treated by these injections did not subsequently develop hydrophobia, therefore the prophylactic was the remedy. This simple proposition loses its force, however, when we note carefully what really happened. In one series, cords were used based on one formula. Some "cures" resulted, but deaths also occurred. Then the formula was altered, and made more intensive, with the result that a larger number of deaths occurred. A return was then made to the first formula, with some slight modification. Deaths still occurred. In explanation of the deaths, a general affirmation was made that the cases that died came "too late." But, in looking through the list of patients, I found that the cases which were "cured" were, in many cases, of just as long duration, and that with regard to them no assertion was made that they came "too late." Take, for instance, the case of Lord Doneraile. If, in his case, eleven days was too late for treatment, then all cases that

¹ Extract from an article by Thomas M. Dolan, M.D., in *The Contemporary Review* for July.